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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the sensibility degradation monitor approach of the acceleration sensor currently installed in the major equipment of a nuclear power plant etc.
[0002]
[Description of the Prior Art] The acceleration sensor has a resonant frequency in a certain frequency from on the structure. For this reason, it is checking that design an acceleration sensor so that a resonant frequency may become high enough to the test-frequency range, and it is generally filling the engine performance as a design in the phase of manufacture using a calibrating apparatus with a high precision of a shaker etc.
[0003] On the other hand, about the precision monitor of the acceleration sensor installed in the device of various plants, such as a nuclear power plant, etc., an acceleration sensor is periodically removed from a device and a check and amendment of sensibility are performed using the level difference over a specific frequency etc.
[0004]
[Problem(s) to be Solved by the Invention] Since the problem of radiation exposure to a worker arises in case the sensitometry of the acceleration sensor which removes an acceleration sensor by the nuclear power plant on the occasion of the correction by sensitiveness of an acceleration sensor and which was activated at the time [the acceleration sensor] is performed, it is in a difficult situation to detect degradation according to individual of an acceleration sensor, and to perform a sensitivity calibration.
[0005] Therefore, the acceleration sensor which once installed and passed a fixed period is in the situation currently exchanged altogether-like the first place, and cost increases for the functional maintenance. For this reason, facilitation of the precision monitor of the acceleration sensor in a nuclear power plant etc., mitigation of a worker's exposed dose, and improvement in economical efficiency were made into the technical problem.
[0006] The place made into the purpose of this invention enables the monitor of sensibility degradation simple, makes easy proofreading of an acceleration sensor, reduction of the cost for a functional check, and the quantitive functional diagnosis to the acceleration sensor especially under a high radiation environment, and is to offer the sensibility degradation monitor approach of the acceleration sensor which reduced a worker's dose of radioactivity, without removing picking combining a means give an impact to an acceleration sensor through a vibration-measurement side, at every inspection of the once installed acceleration sensor.

[0007]
[Means for Solving the Problem] the acceleration sensor installed in the vibration measurement side, and a means to give an impact to said vibration measurement side arranged near this acceleration sensor – and The means which detects the impact signal which was given by means to give this impact and transmitted the vibration measurement side by said acceleration sensor, and carries out record-keeping of that output signal or the frequency-response data, It has a frequency-analysis means against the saved data, and a means to compare and evaluate the frequency spectrum or the power, and the transfer function of the saved data. Before employment of the time of acceleration-sensor installation, And the impact signal emitted from a means to give said impact after acceleration-sensor employment is detected by the acceleration sensor. It is characterized by evaluating sensibility degradation of said acceleration sensor from the saved data as compared with the threshold which permits sensibility degradation of an acceleration sensor with the frequency spectrum or the power, and the transfer function the acceleration-sensor employment back and before acceleration-sensor employment and which was set up beforehand.
[0008]
[Function] The impact signal containing many oscillating components in the resonance frequency of the acceleration sensor given to the vibration measurement side by means to give an impact after the time of installation of an acceleration sensor and employment is detected by the acceleration sensor each time, and record-keeping of the output signal or the frequency-response data is carried out to a data-logging means.
[0009] After inspecting the frequency spectrum to this saved data after employment of an acceleration sensor, it analyzes with a frequency analysis means, and acceleration-sensor sensibility degradation is evaluated from the comparison with the threshold which permits the frequency spectrum of the time of installation of an acceleration sensor or power and a transfer function, and acceleration-sensor sensibility degradation in a comparative-evaluation means and which was set up beforehand.
[0010]
[Example] One example of this invention is explained with reference to a drawing. As shown in the outline block diagram of drawing 1 , generally the acceleration sensor 1 is installed in the vibration measurement side 2 which becomes by structural members, such as an outer wall of a pump case or a reactor primary system pressure boundary.
[0011] Near said acceleration sensor 1, temporary or the impact generator 3 which is a means to always give an impact as a facility is installed in respect of [2] this vibration measurement. The impact generator 3 is what made the subject the pendulum 5 equipped with the metal impact ball 4 with which mass was defined, and generates the RF in which near [many] the resonance frequency of said acceleration sensor were included.
[0012] The impact ball 4 is made to collide with the vibration measurement side 2 in which said acceleration sensor 1 is installed, an impact is given, vibration is emitted, and this aims at maintaining the condition of the field of the vibration measurement side 2 which is a shocked field, and the field of the impact ball 4 which adds an impact in the continuously same condition in the part which performs an impact.
[0013] The impulsive vibration source generated with this impact generator 3 transmits the member of the vibration measurement side 2, is detected by the acceleration sensor 1 for [proofread], and is changed into an electrical signal by the acceleration signal magnification means 6.
[0014] A data-logging means 7 to record the frequency-response data from an acceleration sensor 1 is connected to the acceleration signal magnification means 6, and it consists of frequency analysis means 8, such as FFT (fast Fourier transform) which carries out frequency analysis of this recorded data, and a comparative-evaluation means 9 for evaluating degradation of said acceleration sensor 1 connected to this frequency analysis means 8 further.

[0015] Next, an operation of the sensibility degradation monitor approach of this acceleration sensor by the above-mentioned configuration is explained. In the impact generator 3 installed as permanent installation, as shown in drawing 1 , temporary or the impact ball 4 hung at the tip of a pendulum 5 is made to collide with the same vibration measurement side 2 as said acceleration sensor 1 to near in which the acceleration sensor 1 was installed in respect of [2] the vibration measurement which becomes by various kinds of structural members as the 1st example, and an impact is added to it.
[0016] After the impact signal generated on that occasion is detected by the acceleration sensor 1 and amplified by the acceleration signal magnification means 6, it is recorded on the data-logging means 7. First, when this activity installs an acceleration sensor 1 first, it is performed, and it records this initial data.
[0017] Next, after the device which installed the acceleration sensor 1, and a plant are operated and predetermined carries out period progress, at the times, such as a periodic check at the time of an acceleration sensor 1 proofreading, for example, an entire plant, the impact generator 3 is operated with the same procedure as the above, and the data of the impact signal by the acceleration sensor 1 are extracted and recorded again.
[0018] As the frequency analysis means 8 performs frequency analysis and the impact signal data recorded on the data-logging means 7 at this time and the impact signal data recorded in the time of installation of said acceleration sensor 1 are shown in the frequency spectrum Fig. of drawing 2 , in the comparative-evaluation means 9, comparison and evaluation of the characteristic curve 10 (continuous line) of the time of acceleration-sensor installation and the characteristic curve 11 (dotted line) in which the present sensibility deteriorated are done.
[0019] The comparison and evaluation at this time set up beforehand the threshold defined on frequency spectrum with the precision required of an acceleration sensor 1, and evaluates and checks the soundness of an acceleration sensor 1 by checking that the response of the current acceleration sensor 1 has not deviated from the range of that threshold.
[0020] In addition, when the impact generator 3 is always considered as a facility, it becomes possible to carry out proofreading of an acceleration sensor 1, or a sensibility check at the stage of arbitration other than the time of a periodic check if needed by considering as the remote operation which does not illustrate an impact generating activity. It is a degree in order to perform impact generating on the occasion of the sensibility degradation monitor of an acceleration sensor 1 here paying attention to change of the response characteristic in acceleration-sensor resonance frequency with the high sensibility in an acceleration sensor 1. If the mass of the impact ball 4 of the impact generator 3 is selected by (1) type, it will become possible to detect the indication of degradation of the acceleration sensor 1 with high degree of accuracy further.
[0021] That is, the impact ball 4 doubles the time amount T in contact with the vibration measurement side 2 with about 1/2 order of the period Ta of the resonance frequency F of an acceleration sensor 1. Contact time T It can obtain by (1) formula.
$T=3.22m2/5-(Ks+Kd)2/5v-1/5$ – (1) For the mass Ks and Kd of an impact ball, the physical-properties value v of an impact ball and an impact partner is [m] a collision rate however Ks, and d=(1- nu s, d)2/(pi-Es, d) here.
[nu: Poisson's ratio and E:Young's modulus].
[0022] By this, the impact generator 3 generates the impact signal which fully contained the component near the acceleration-sensor resonance frequency, it makes it possible to catch sensibility degradation of acceleration-sensor resonance frequency with a sufficient precision, and it becomes possible to also detect the abnormality indication of few acceleration sensors 1 which do not appear as a fall of the response level of a resonance frequency band in the frequency band below the resonance frequency of an acceleration sensor 1 usually used.

[0023] In addition, resonance of the acceleration sensor installed in a reactor primary system When aimed at the acceleration sensor 1 which is about 25kHz, the mass of the impact ball 4 suitable for impact generating is about 1 thru/or 10g. Moreover, the above Since impact velocity has only the effectiveness of the order of the 1/5th power to the contact time of the impact ball 4 so that clearly also from (1) type, a detailed convention is not especially needed by setting as range of the rate which can add an impact to the vibration measurement side 2 actually for the purpose of proofreading of an acceleration sensor 1.
[0024] Furthermore, as the 2nd example, when carrying out proofreading of an acceleration sensor 1 when an acceleration sensor 1 is first installed for data extraction of the impact signal for performing frequency analysis and, multiple-times operation of the actuation of the impact generator 3 is carried out, respectively. In case it asks for frequency spectrum in the frequency analysis means 8, compared with the 1st example of the one above-mentioned example, it can ask for the shock response spectrum stabilized further by calculating the average of the frequency spectrum of each impact signal.
[0025] As it asks for the power of an impact signal from the area of the frequency spectrum shown in drawing 2 detected in the 1st example of the above as the 3rd example, i.e., the area of a characteristic curve 10 (continuous line) and a characteristic curve 11 (dotted line), and is shown in the transition property Fig. of the oscillating power of drawing 3 paying attention to transition of this value, the transition curve 12 of power level detects sensibility degradation of the acceleration sensor 1 by having fallen from the threshold 13 set up beforehand.
[0026] The 4th example is a thing in case there is a vibration measurement side 2 horizontally, and as shown in the important section block diagram of drawing 4 , the impact generator as a means to give an impact carries out natural fall of the impact ball 4. In addition, in order to fix the rate in the case of an impact and to keep impulse force constant, high proofreading of precision can be performed more by maintaining uniformly with the impulse force regulator which does not illustrate the height 14 from the vibration measurement side 2 held in order to drop the impact ball 4.
[0027] It is the 5th example which was shown in the outline block diagram of drawing 5 , and is what the impact generator 15 as a means to give an impact gives initial velocity to the impact ball 4, and injects to the vibration measurement side 2 using the air gun 16 or a spring. It is easy to change initial velocity, to change impulse force, or to inject many impact balls 4 continuously, and to acquire the impact signal of the multiple times stated in the 2nd example of the above.
[0028] The 6th example installs the acceleration sensor 17 for criteria in other parts of the vibration measurement side 2 in which the acceleration sensor 1 for [proofread] is installed near the impact generator 3 temporarily, as shown in the outline block diagram of drawing 6 .
[0029] The impact generator 3 is operated and the impact signal acquired from each acceleration sensor 1 and 17 via the acceleration signal magnification means 6 and 18 is recorded on the data recorder 7. Proofreading is performed by comparing the transfer function obtained from the output of the acceleration sensor 17 for criteria, and the output of the acceleration sensor 1 for [proofread].
[0030] This proofreading analyzes the transfer function spectrum of the curve 19 (continuous line) before sensibility degradation of the acceleration sensor 1, and the curve 20 (dotted line) after sensibility degradation with the frequency analysis means 8, as shown in the transfer function spectral characteristics Fig. of drawing 7 , and it is performed paying attention to change of the transfer function obtained from two acceleration sensors 1 and 17, and the comparative-evaluation means 21 estimates it.

[0031] in addition, in order to detect change of the response with the contact resonance frequency of the acceleration sensor by which degradation of an acceleration sensor tends to appear with sufficient sensibility as an embodiment of above-mentioned this invention It is order near in the mass of the ball used for an impact T=3.22m2/5-(Ks+Kd)2/5v-1 / 5 (here) m is good to determine that the mass of an impact ball, and Ks and Kd are set to physical-properties value K=(1-nu)2/(pi-E) [nu:Poisson's ratio and E:Young's modulus] of an impact ball and an impact partner, v is set at a collision rate, and it is set to sensor resonant period Ta=Tx2 by the mass m and impact velocity v of an impact ball.
[0032]
[Effect of the Invention] Without removing an acceleration sensor from a vibration measurement side above according to this invention, it becomes possible to supervise sensibility degradation of an acceleration sensor simple, the quantitive functional diagnosis to an acceleration sensor can be easily carried out on the occasion of the vibration measurement under a high radiation environment, and the dose of radioactivity to a worker is reduced. Moreover, it is effective in the cost for proofreading of the acceleration sensor in large-scale plants, such as a general electric power plant, and a functional check being reduced.